

A STUDY ON EXTRACTION AND APPLICATION OF ECO – FRIENDLY NATURAL DYE EXTRACTED FROM LEAVES OF *ACALYPHA INDICA* LINN ON SILK FABRIC

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ABSTRACT

The present investigation was carried out to revive the old art of dyeing with natural dye from leaves of *Acalypha indica* Linn. It belongs to family Euphorbiaceae, commonly known kuppaimeni. The dye has good scope in the commercial dyeing of silk in garments industry. In the present study, degummed silk fabrics were dyed with chemical and natural mordants. Dyeing was carried out by pre-mordanting, post mordanting and simultaneous mordanting. The dyed samples have shown good washing, light, rubbing fastness and perspiration fastness properties. The various colour changes were measured by computer colour matching software. ICPMS studies have proved that, heavy metals such as antimony, arsenic, cadmium and lead were not present in the dye extract. Anti-bacterial and anti-fungal activities of the dye were also studied.

KEYWORDS: Extraction, Natural Dye, Leaves, *Acalypha indica* Linn. Silk, Textiles

INTRODUCTION

Natural dyes have become a part of human life since time of immemorial. The alchemy of colours started its use from an early time. Use of natural dyes in colouration of textile materials and other purpose is just one of the consequences of increased environmental awareness (Vankar, P.S. (2000)). Natural dyes are known for their use in colouring of food substrate, leather, wood as well as natural fibers like cotton, wool, silk and flax as major areas of application since ancient times. Natural dyes may have a wide range of shades and can be obtained from various parts of plants including roots, bark, leaves, flowers, and fruit. Since the advent of widely available and cheaper synthetic dyes in 1856 having moderate to excellent colour fastness properties, the use of natural dyes having poor to moderate wash and light fastness has declined to a great extent. However, recently there has been revival of the growing interest on the application of natural dyes on natural fibers due to worldwide environmental consciousness (Ashis Kumar Samanta et al., (2009)). In many of the world's developing countries, natural dyes can offer not only rich and varied source of dye stuff, but also the possibility of an income through sustainable harvest and sale of these plants (G.W. Taylor, (1986)).

The use of natural dyes for textile dyeing purposes, decreased to a large extent after the discovery of synthetic dyes in 1856. As a result, with a distinct lowering in synthetic dye stuff costs, the natural dyes were virtually unused at the beginning of twentieth century (D.Jothi, (2008)). Presently there is an excessive use of synthetic dyes, estimated at around 10×10^6 tons per annum, the production and application of which release vast amount of waste and unfixed colorants causing serious health hazards and disturbing the eco-balance of nature (A Purrohit et al., (2007)). Nowadays, fortunately, there is increasing awareness among people towards natural dyes. Natural dyes are preferred in developed countries, because they are non-allergic, non-carcinogenic and have lower toxicity and better biodegradability than the synthetic dyes.

Acalypha indica Linn is a species of plant having catkin type of inflorescence (figure 1). It is a common herb growing up to 75 cm tall with ovate leaves. Flowers are green, unisexual found in catkin inflorescence. In West Africa the leaves are cooked and eaten as a vegetable. The common names of *Acalypha indica* are Indian acalypha, Indian nettle (English), Poonamayakki and Kuppaimeni (Tamil). Root is used to remove worms in children and given in the morning empty stomach work as mild laxative and also remove worms and used in chest pain, joint pain, migraine blood dysentery, etc.

The extract of the root lowered the blood sugar level up to 30 %. Leaves with turmeric used for relief from acne and pimples. The leaves are laxative and used externally as emollient, a poultice is used for chilblains, in insect bites, swelling, rheumatism and facial paralysis. Leaves possess anti- periodic and laxative properties, the leaves are used in jaundice, piles, rheumatism ulcers and also externally skin eruptions, ring worms, eczema. The leaves extract are applied to pustules, insect bites (D.Jagatheeswari et al., (2013)).

MATERIALS AND METHODS

Materials

Source

The Leaves of *Acalypha indica* Linn was Collected from Mariamman Kovil, Thanjavur District (Figure 2)



Figure 1: *Acalypha indica* Linn Plant

Figure 2: Leaves of *Acalypha indica*

Substrates

Degummed silk fabric was used for used for dyeing.

Chemicals Used

AR grade metallic salts such as copper sulphate, ferrous sulphate, alum [$K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$], potassium dichromate, nickel sulphate and stannous chloridewere used as chemical mordants. Myrobolan and cow dung were used as natural mordants.

Experimental Methods

Dye Extraction

Leaves of plant were soaked in 70% ethanol and heated in a beaker kept over a water bath for 2 hours to facilitate quick extraction. Then it was filtered and the filtrate was collected in a separate beaker.

Dyeing Procedure

The silk samples were dyed with dye extract keeping different M: L ratio such as 1:10, 1:20, 1:30, 1:40. Dyeing was carried out at different temperature like 40°C, 60°C and 80°C and continued for 1 hour.

Mordanting

The silks samples were treated with different chemical and natural mordants by following three methods (P.Saravanan et al., (2013)).

- **Pre-Mordanting:** In this method, samples were pretreated with the solution of different chemical and natural mordants and then dyed with dye extract.
- **Post Mordanting :** In this method, dyed silk samples were treated with solution of different chemical and natural mordants.
- **Simultaneous Mordanting :** In this method, the silk samples were dyed with dye extract as well as different chemical and natural mordants.

Colour Fastness

The dyed samples were tested according to IS standards. Colour fastness to washing, light and rubbing were determined from standard test methods IS-687-79, IS-2454-85 and IS-766-88 respectively.

Measurement of Colour Strength

The spectral reflectances of the dyed samples were measured using a Text flash spectrophotometer (Data colour corp.). The K/S values were calculated by Kubelka-Munk equation.

$$K / S = (1 - R)^2 / 2R$$

Where R is the decimal fraction of the reflectance of the dyed samples at λ_{\max} . K is the absorption coefficient and S is scattering coefficient (S.Habibzadeh, et al., (2010)).

ICPMS Studies

The presence of heavy metals like antimony, arsenic, cadmium and lead in dyed fabric causes dermatological problems to the wearer and also eco-friendly dye should not contain these heavy metals (Pabita Saha et al., (2010)). The presence / absence of these heavy metals were tested by Inductive Coupled Plasma Mass Spectrometer (ICPMS).

Anti-Bacterial and Anti-Fungal Activity Studies

Antibacterial Activity

For the purpose of antibacterial evaluation, five bacterial pathogens were used (Rajni Singh et al., (2005)). *Staphylococcus* sp., *Salmonella typhi*, *Klebsiella* sp., *Staphylococcus aureus* and *Escherichia coli* (Gram-negative bacteria) were employed for determination of antibacterial activity of the dye.

Antifungal Activity

For the purpose of antifungal evaluation, five fungal pathogens were used (Rajni Singh et al., (2005)). *Aspergillus fumigatus*, *Microsporum canis* (molds), *Cryptococcus* sp., *Candida albican* (yeast) and *A.flavus* were employed for determination of antifungal activity of the dye.

RESULTS AND DISCUSSIONS

Preparation and Optimization of Ethanolic Extract of *Acalypha indica* Linn

The leaves of *Acalypha indica* Linn were found to discharge colour in 70% ethanol very easily. Increasing the quantity of leaves 5 g to 20 g per 100 mL 70% ethanol boiled for 1 hour is accompanied with the increase in colour

strength and depth in colour (Rakhi Shanker et al., (2006)). It was observed that, colour of the dye extract was greenish yellow.



Figure 3: Ethanolic Extract from Leaves of *Acalypha indica* Linn

Effect of M: L Ratio

The silk samples were dyed with dye extracts keeping various M: L ratio as 1:10, 1:20, 1:30 and 1:40. It was observed that the dye uptake was good in M: L ratio 1:30.

Effect of Temperature

The effect of temperature on the dyeability of silk fabrics dyed with dye extract at different temperatures like 40°C, 60°C and 80°C. It was clear that the colour strength (K/S) values increased with increase of dyeing temperature.

Effect of Mordanting

The silk fabrics were treated with different chemical and natural mordants by three methods such as pre mordanting, post mordanting and simultaneous mordanting. These three methods gave different colour on the silk fabrics. It was observed that, the dye uptake was found to be good in post mordanting method than the other two methods are shown in figure 4.

Optimization of Mordants with K/S Value and Colour Hue Changes

Various hues of colour were obtained from post mordanted silk with copper sulphate, ferrous sulphate, alum $[(K_2SO_4 \cdot Al_2(SO_4) \cdot 12H_2O)]$, potassium dichromate, nickel sulphate, stannous chloride, myrobolan and cow dung as shown in Table 1. The different mordants not only cause difference in hues of colour and significant changes in K/S values but also changes in L^* values and brightness index value. The effect of mordants on colour values of silk dyed with leaves of *Acalypha indica* Linn is shown in figure 5.

Table 1: Colour Produced on Silk by Different Mordanting Methods

S. No	Metallic salts	Post mordanting	Pre mordanting	Simultaneous mordanting
1	Copper sulphate			
2	Ferrous sulphate			
3	Potassium dichromate			
4	Nickel sulphate			
5	Alum			
6	Stannous chloride			
7	Cow dung			
8	Myrobolan			

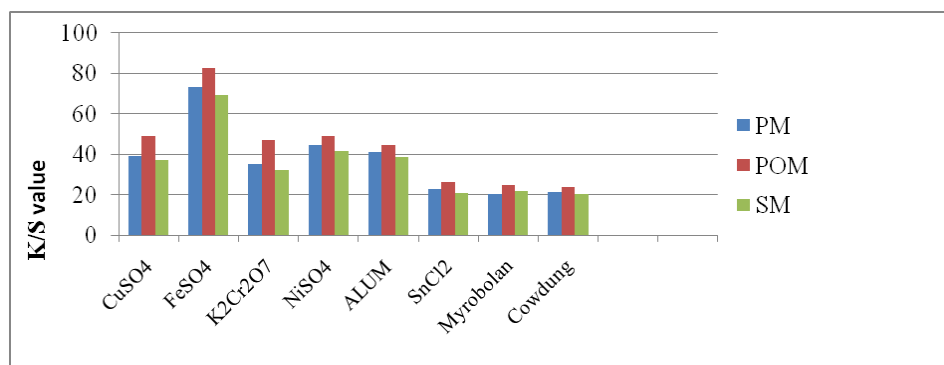


Figure 4: Surface Colour Strength (K/S Values) of Dyes Silk Fabrics after Pre, Post and Simultaneous Mordanting Methods

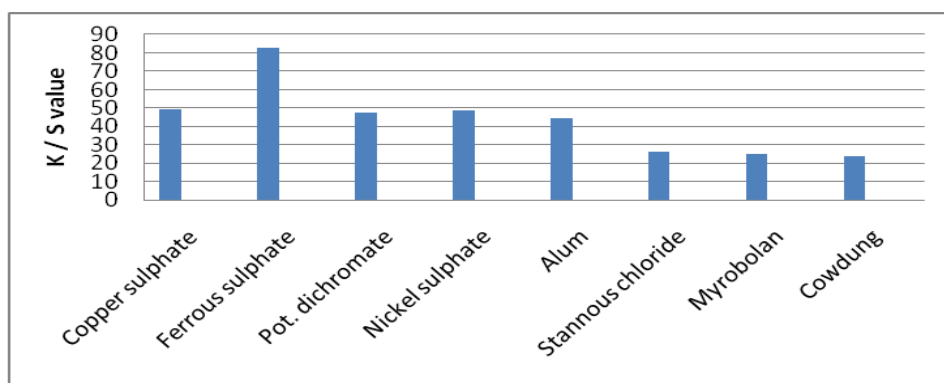


Figure 5: Effect of Mordants on Colour Values of Dyed Silk Fabrics

Table 2 shows L^* , a^* , b^* and K/S values and it can be seen that, mordants which show higher value of L^* show lighter shades while lower L^* value show darker shades for silk. Similarly, negative values of a^* and b^* represent green and blue respectively. Among the chemical mordants used, the highest colour value ($K/S = 82.56$) was obtained with ferrous sulphate and lowest colour value ($K/S = 26.33$) with stannous chloride. Natural mordant like myrobalan showed the higher colour value ($K/S = 24.63$) than the cow dung ($K/S = 23.61$).

Table 2: Different Post Mordants, L^* , a^* , b^* and K/S Values For Dyed Silk *Acalypha indica* Linn

S.No	Mordants	L^*	A^*	B^*	K/S Value
1	Copper sulphate	76.34	4.55	14.51	49.08
2	Ferrous sulphate	73.05	1.835	10.56	82.56
3	Potassium dichromate	77.26	3.46	15.76	47.17
4	Nickel sulphate	73.19	3.54	20.63	48.87
5	Alum	83.19	1.76	23.67	44.57
6	Stannous chloride	80.57	3.54	21.17	26.33
7	Myrobalan	81.53	2.84	18.45	24.63
8	Cow dung	84.51	2.45	17.96	23.61

Fastness Properties

It was observed that, dyeing with *Acalypha indica* Linn gave good fastness properties. The fastness properties of dyed silk fabrics are shown in Table 3. Overall, it could be used for commercial purposes and attain acceptable range.

Table 3: Fastness Properties for Silk Fabric Dyed with *Acalypha indica* Linn

S. No	Mordants	Washing (IS-687-79)	Light (IS-2454-85)	Rubbing (IS-971-83)	
				Dry	Wet
1	Copper sulphate	4 – 4/5	IV	4 – 5	4
2	Ferrous sulphate	4 – 5	IV	4	3 – 4
3	Potassium dichromate	5	V	4 – 5	4
4	Nickel sulphate	4	IV	4	3 – 4
5	Alum	4 – 4/5	III	4 – 5	3 – 4
6	Stannous chloride	4 – 4/5	IV	4	3 – 4
7	Myrobolan	4 – 5	IV	4	4
8	Cow dung	3 – 4	III	3 – 4	3 – 4

ICP-MS Studies

Inductive Coupled Plasma Mass Spectrometer (ICPMS) studies have proved that, heavy metals such as antimony, arsenic, cadmium and lead were not present in the dye extract obtained from leaves of *Acalypha indica* Linn.

Anti-Bacterial and Anti-Fungal Activity of the *Acalypha indica* Linn

This study proved that ethanol extract of leaves from *Acalypha indica* Linn were effective against two bacterial *Escherichia coli* (Gram-negative bacteria), *Staphylococcus aureus* (Gram-positive bacteria) and for anti-fungal activity against three fungi, *Aspergillus fumigatus*, *Microsporum canis* (molds) and *Candida albican* (yeast).

CONCLUSIONS

The present work shows that, leaves of *Acalypha indica* Linn can be used as dye for colouring textiles. These are grown throughout India and it is easily available plant. Different shades of colour can be obtained using different chemical and natural mordants. The washing, light and rubbing fastness of all dyeing with mordants were quite good and also dye extract has shown good antibacterial antifungal activity. The dye has good scope in the commercial dyeing of silk.

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